Measuring the Education Function of Government

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Introduction

Education is one of the largest functions of government, accounting for 29.5 percent of government consumption and 4.6 percent of gross domestic product in 2003.[1] Since public education is rarely bought and sold in a market, there is no straightforward way to estimate a time series of the real output of educational services produced by government. Instead, there are many different options available, corresponding to the different assumptions one must make in the absence of markets. It is a goal of the Bureau of Economic Analysis (BEA) to take advantage of these options and create a suite of alternative measures of real public education output.

As part of a broader move to treating government as a producer, BEA is using the case of education to explore alternative metholodologies of estimating government output. These methodologies will measure government output separately from government inputs, producing especially useful estimates for studies of growth, inflation, and productivity in the government sector. Three categories of alternatives are discussed here: alternatives based on market prices or proxies thereof; alternatives based on various quantity or physical measures—including quality-adjusted indicators—used to proxy real changes in real output; and alternatives based on a human capital approach. Alternatives based on prices include adjusting the price of educational inputs to adjust for quality differences that affect educational outcomes and use of private tuition as a proxy for the price of public education. Alternatives based on quantity or physical measures include indexes of pupil enrollment, promotions and graduations, enrollments adjusted for the quality of school inputs, and enrollments adjusted for student achievement. This is the

[1] U.S. Bureau of Economic Analysis, National Income and Product Accounts, Tables 1.1.5 and 3.17. Education is measured as government consumption for education.

approach used by the relatively small number of statistical agencies in other countries that have examined alternative measures of government output. Alternatives based on a human capital approach estimate the marginal value of an additional year of education by, for example, estimating the present discounted value of education's impact on future earnings.

BEA currently assumes that the output of government services is equal in both nominal and real terms to government consumption. Since government consumption is equal to the cost of inputs used to produce government services, this measure of government output is often called an "input" measure of government output. This approach implicitly measures the quantity of government services with a cost-weighted index of the inputs used to produce them. The main drawback of this approach is that it does not measure the prices and quantities of the outputs produced by governments separately from the prices and quantities of the inputs purchased by governments.

Government as a Producer

As previously noted, the measurement of the real output of the education function of government is part of a larger research project by BEA to estimate the real output of federal, state, and local governments. The project reflects a change in BEA's conceptualization of the function of governments that began with the 2003 comprehensive revision of the National Income and Product Accounts (NIPAs). The new treatment recognizes the government as a producer of services rather than as a final purchaser of goods and services (Moulton and Seskin, 2003). It lays out the basics of a government production account that identifies government inputs and outputs in the same way that inputs and outputs in the private sector are identified in the input-output and

GDP-by-industry accounts. It also raises the share of services in GDP. In the education case, the revision changed BEA's view of the education function of government from a consumer of teachers, textbooks, and chalk to a producer of educations and extracurricular activities.

The shift towards government as a producer is one of the reasons BEA began publishing NIPA tables of real government consumption and gross investment by function in October 2004 (Baker, Kelly, and Robinson, 2004). The measures of government consumption and gross investment in these tables are based on the cost of inputs purchased by governments. The tables present separate measures for defense, education, health, transportation, and other government services, in both nominal and real terms. The measure of real government consumption for education includes real compensation of teachers and other employees, consumption of fixed capital, and net purchases of goods and services. Teacher inputs are currently quality-adjusted by BEA for years of experience and highest degreee obtained.

The second phase of the shift towards government as a producer is the construction of independent output measures for government. The research project which this paper describes is an important part of that second phase. It is recognized that coming up with independent measures of output, which are useful in analyses of economic growth, including productivity and inflation, is a challenging undertaking requiring a substantial research effort.

If government services were sold in markets, BEA could calculate independent measures of real output by deflating consumer expenditure on government services by a consumer price index for government services. Unfortunately, government services such

as education are generally not bought and sold in markets. Consequently, they lack explicit prices and quantities.

In the absence of markets, BEA assumes that the real output of government services is equal to real consumption by governments—an "input" measure of government output that assumes that real output is equal to real cost of inputs. Under this approach, real government output of educational services equals real compensation of teachers and other employees, consumption of fixed capital, and net purchases of goods and services. Note that this does not imply that real government output of educational services *is* real compensation of teachers, etc. The two are different things; the former is a set of services produced by government, while the latter is the cost of inputs used to produce the services. The two are simply assumed, for now, to have the same value.

Input measures of government output are not independent of measures of the cost of government inputs; in fact, the two are perfectly correlated. A by-product of this correlation is an implicit assumption that more spending by governments on inputs necessarily leads to more output of government services. In the education case, if public schools purchase resources that are plainly useless, it nonetheless shows up in the GDP accounts as greater output. On the other hand, if public schools make better use of their existing resources, it does not appear in the GDP accounts at all. The productivity of the education function of government is assumed to be constant over time, even if it clearly is not.

Given the problems of the input measure, BEA is exploring independent measures of the real output of government services such as education. These measures have several advantages. Independent measures of real output of government services and real

cost of government inputs can be compared to measure the productivity of the government sector. Changes in nominal government consumption can be decomposed into changes in the prices and quantities of government services rather than the prices and quantities of government inputs. These analyses can be conducted separately by government function if desired; for example, growth in the government education sector can be compared in real terms to growth in the government health sector.

Price Indexes

There are several ways to measure output independently of the cost of inputs. Price indexes, which are used to deflate nominal output, are most commonly used by BEA to derive measures of real output. To construct price indexes, we need prices, preferably quality-adjusted, for government educational services. Since public education is generally not sold in a market, prices are not available. However, it is important to note that education is not a government monopoly, and that there are non-profit and for-profit private schools at all levels of education. These schools sell their services in markets and charge prices for education, though non-profit schools are often subsidized by churches or endowments and priced below cost. One could measure real output of government educational services by dividing nominal government consumption for education by an index of prices for private education. This approach assumes that private education is a comparable service to public education with a comparable cost of production. It also assumes that prices of educational services in the private sector actually are market prices.

Quantity Extrapolation

Another approach to calculating real output is quantity extrapolation. This approach uses direct measures of the quantity of goods and services produced, and is already used by several European countries to measure the real output of education (Atkinson, 2005). The most straightforward direct measure of the quantity of government educational services is probably a simple count of pupils in the public education system.

Quantity extrapolation can be used to measure the education function of government in the following way. In a base year, real government output of education is assumed to be equal to nominal government consumption for education in a base year. Across years, the rate of growth in real government output of education is equal to the rate of growth in the measure of the quantity of government educational services. As a result, in any given year, real government output of education is equal to base-year nominal government consumption for education times the ratio of the quantities in the current and base years. Mathematically, this can be expressed in (1):

$$Q_t = \frac{\theta_t}{\theta_b} GCE_b \qquad (1)$$

where Q_t is real government output of education, GCE_t is nominal government consumption for education, and θ_t is the measure of the quantity of educational services in year t. The base year is b. The resulting measure of output, Q_t, is often called a "quantity" or "volume" measure of government output. The implicit price deflator for government educational services is $P_t = GCE_t/Q_t$, which equals one in the base year. A productivity measure for government educational services is $\pi_t = Q_t/RI_t$, where RI_t is an index of the real cost of inputs purchased by government for education in year t. Since

quantity measures of government education output are used in other countries, we will discuss them in some detail.

Unadjusted Quantity Measures of Government Output

As mentioned above, the simplest measure of the quantity of government educational services is probably a simple count of pupils. Using a simple count of pupils assumes that the educational services governments produce are years of education, that years of education are the same across the elementary and secondary grades, and that years of education produced in the present are of the same quality as those produced in the past. This count has grown at a substantially slower rate than the input measure of government education output, as real government spending per pupil has increased significantly. The case of state and local government output of elementary and secondary education is illustrative. Between 1980 and 2001, real state and local government consumption for elementary and secondary education grew at an annual rate of 2.4 percent per year.[2] In contrast, the number of pupils educated in public elementary and secondary schools increased at an annual rate of only 0.7 percent.[3] If one accepts a simple count of pupils as a good measure of the quantity of educational services, the 1.7 percentage point difference between the two measures implies a 1.7 percent annual decrease in the productivity of public education. The productivity decline is primarily a result of the assumption that the quality of education produced in public schools is unchanged over time despite increased real spending per pupil.

A more complicated measure of the quantity of educational services is an index of pupil counts that distinguishes among different kinds of pupils and accounts for them

[2] U.S. Bureau of Economic Analysis, unpublished detail from the NIPA accounts.
[3] U.S. Department of Education, *Digest of Education Statistics 2003*, Table 2.

differently. For example, the educations that elementary and secondary pupils receive are considerably different, and it might not be appropriate to account for them as if they were the same thing. Aggregating them as if they were two different services may be a better approach. Unfortunately, though it is relatively easy to calculate separate counts of elementary and secondary students, it is difficult to find separate accounts of expenditure on elementary and secondary education. Consequently, calculation of an aggregate such as a Fisher index, which requires cost shares, may not be possible. It may be necessary to adopt a simpler weighting scheme.

The Case of Special Education

Another distinction one may want to make when counting pupils is that between regular and special education students. Special education costs considerably more per student than regular education and has made a small but important contribution to rising educational costs in recent years (Chaikind, Danielson and Brauen, 1993; Hanushek and Rivkin, 1997). Counting special education students is quite easy; a rich set of data about students, teachers, and staff in special education are available in the U.S. Department of Education's annual reports to Congress about the implementation of the Individuals with Disabilities Education Act. There are considerably less data on actual expenditure on special education, which makes aggregating regular and special education with an index such as a Fisher index relatively difficult.

Using Promotions Instead of Enrollments

A count or index of pupils who complete the grades in which they are enrolled—leading to graduation or promotion to the next grade—is another straightforward measure of the quantity of the government educational services. This approach assumes that

students who enroll in but fail to complete a grade of school receive no educational services. A hybrid approach that assumes that non-promoted students receive a lesser educational service than promoted students is another option. A problem with using promotions instead of enrollments is that standards for promotion or graduation may change idiosyncratically over time, causing the measured output and price of government educational services to change idiosyncratically as well.

Quality-Adjusted Quantity Measures of Government Output

So far, we have assumed that the quality of government educational services is constant. A more complex but possibly more complete measure of the quantity of educational services is a count or index of pupil enrollments adjusted for changes in the quality of education over time. A mathematical expression of such a measure is (2):

$$\theta_t = E_t \times f(\mathbf{x}_t) \qquad (2)$$

where θ_t is a measure of the quantity of educational services, E_t is a count or index of enrollment in public schools, and $\mathbf{x}_t$ is a vector of variables that indicate the quality of education in year t. The function $f(.)$ is the quality adjustment. The challenge of a measure like (2) is choosing the right variables for $\mathbf{x}$ and the right specification for $f(.)$. The ideal specification of $f(.)$ would accurately describe how the school quality variables in $\mathbf{x}$ can substitute for extra years of schooling in the production of educational services.

Using School Inputs to Adjust for Quality

One possible measure of the quantity of education adjusts for the quality of the inputs used to produce it. This approach incorporates variables such as teacher education, teacher experience, and the pupil-teacher ratio into the quality adjustment. The resulting measure of education output is similar to the currently used input measure

in the sense that increases in particular school inputs will mechanically lead to increases in both measures. However, the reason this is the case differs between the two measures. School inputs affect an input measure of output to the extent to which they affect the real cost of providing education. In contrast, school inputs affect a quantity measure of output to the extent to which they are believed to affect the quality of education provided. Consequently, a change in an expensive school input that is not very relevant to the quality of education will lead to a large change in the input measure and little or no change in the quantity measure.

Relating the Academic Literature on School Inputs to Quality Adjustment

Using school inputs to adjust for the quality of education requires knowing which school inputs affect the quality of education, and by how much. A large academic literature exists about the effect of school inputs on student outcomes, and consensus is often hard to find in that literature. In a widely cited literature review, Hanushek (1997) argues that most measurable school inputs, including teacher education, teacher experience, teacher salaries, and class size, do not appear to have a significant effect on academic performance. Krueger (2003) disagrees with Hanushek's conclusions, particularly with respect to class size; Hanushek (2003) responds in kind.

This literature, which estimates the effect of school inputs on specific student outcomes, needs to be related to BEA's project, which is concerned with specifying a quality adjuster that accurately describes the substitutability of school inputs for years of schooling. Consider the case of class size. In a paper that is similar in approach to much of the literature on school inputs, Rivkin, Hanushek, and Kain (2005) found that a one-student decrease in class size increased the test scores of Texas 4th, 5th, 6th, and 7th

grade students by about 0.005 standard deviations. What does this tell us about the number of extra years of schooling a one-student reduction in class size is worth? One way to try to find out is to use the economic return to education. Suppose the economic return to a year of schooling is 10 percent, as suggested by Jaeger (1997). Also suppose, as Krueger (2003) does, that a standard deviation increase in test scores is associated with an 8 percent increase in earnings. Under these assumptions, a one-student decrease in class size leads to a $(0.005 \times 8 \div 10) \times 100\% = 0.4$ percent increase in the economic return to a year of schooling. We might infer from this that a one-student decrease in class size also leads to a 0.4 percent increase in the quality of schooling. This inference implicitly assumes that the benefits of small classes are accurately and sufficiently accounted for by their effect on testable cognitive skills, and that the effect of a school input on the private economic return to education is a good estimate of its effect on the overall quality of education. Since Rivkin, Hanushek, and Kain (2005) study classes of about 20 students each, an elasticity approach would associate a one percent decrease in class size with a $0.4 \times 20 \div 100 = 0.08$ percent increase in the quality of schooling.

Using Student Outcomes to Adjust for Quality

School inputs are not the only variables that can be used to adjust for the quality of education. An alternative measure adjusts for the quality of education with a measure of the academic achievement of pupils. Two readily available academic achievement measures are test scores and promotion rates. The National Assessment of Educational Progress (NAEP) Long-Term Trend dataset offers several series of academic subject test scores that are comparable over time. For example, the NAEP suggests that mathematics test scores of 9-, 13-, and 17-year-olds have increased steadily since 1982. Graduation

rates can be calculated from the October school enrollment supplements of the Current Population Survey and are often published by the Department of Education in the annual *Digest of Education Statistics*.

A problem of using either of these measures to adjust for quality is that changes in test scores and promotions over time are caused not only by changes in the quality of schooling but also by changes in the demographic and family backgrounds of the student population. As a result, any serious attempt to measure the quality of schooling with scores or promotions should attempt to strip away the components of these variables that are determined by factors other than schooling. Hoxby (2003) has already attempted this with NAEP microdata, regressing test scores on the demographics and family backgrounds of the students tested in one year of NAEP, using the results of that regression to predict the scores of the students tested in the other years of the NAEP, and subtracting the resulting time series of predicted test scores from the time series of actual test scores. As mentioned above, an extra problem with promotions is that the standards for promotion may change idiosyncratically, and so the rate at which promotions take place may change for reasons exogenous to school or student quality.

The Human Capital Approach

An alternative measure of the quantity of education output, separate from the enrollment and promotion counts suggested above, is the economic value of the human capital produced by schooling. This could be measured as the sum over all pupils of the present discounted values of the lifetime economic return to a marginal year of schooling (Jorgenson and Fraumeni, 1992). The data requirements for estimating such a measure are very great. Additionally, the economic return to schooling is notoriously tricky to

estimate from cross-sectional data because of its endogeneity to the decision to pursue more schooling (Card, 2001). Estimation challenges aside, the human capital measure has some interesting time-series qualities. It is very likely that the economic return to schooling has increased substantially in recent years as a result of rising demand for skills by employers (Katz and Murphy, 1992). When this is the case, the human capital measure increases, even if all aspects of schooling—including the number of pupils taught—have remained exactly the same.

Multiple Outputs and Externalities

All of the measures mentioned above construe schools as producing a single output, education, that is consumed by students and is academic in nature. It is probably more realistic to understand the education function of government as producing multiple outputs. Some of the outputs improve students in non-academic ways; health and physical education classes improve student health and fitness, and extracurricular activities exist in part to improve social and leadership skills. Other outputs simply make the daily lives of students better. This is especially prevalent in public higher education, which offers its students housing, meals, recreation, and entertainment. A measure of real output whose components are limited to academic variables such as class size or test scores ignores these outputs, treating them as if they had no economic value. But it is unquestionably true that students gain something from these outputs, even if it is not strictly related to their education.

Schools also have effects on the communities around them. For example, one of the arguments in favor of after-school programs is that they reduce juvenile crime. If we think of students as the consumers of education and the benefits of education to the

community at large as externalities, then it might not be appropriate to consider these effects as outputs that belong in GDP. Virtually all goods and services are valued in the calculation of GDP by their prices, which are generally determined in markets that ignore externalities. On the other hand, if we think of the public as a whole as the consumer of education, then the effects of schools on their communities are outputs that potentially do belong in GDP. Since schools are normally funded by the public as a whole, this may be the more accurate description.

There are many different ways to deal with non-academic or non-student outputs. It might be possible in cases in which good data exist and quantifying the output is straightforward to create separate accounts for outputs such as extracurricular activities. In other cases, however, there may be no choice but to overlook some outputs. This may particularly be the case of the relatively intangible outputs that schools create for the communities around them.

The Approaches of Other Countries

Countries that have adopted alternative measures of public education output have all chosen to use quantity measures, and have generally taken cautious approaches in measuring the quantity of educational services (Atkinson, 2005). Australia uses full-time equivalent enrollments without making any quality adjustments in primary, secondary, and higher education. The measure used in the United Kingdom, which only covers primary and secondary education, also uses full-time equivalent enrollments, but assumes a 0.25 percent yearly increase in the quality of education. The Netherlands uses a combination of enrollments, graduations, and promotions.

Conclusion

In light of all these possibilities, BEA plans to offer a spectrum of alternative measures of the output of the education function of government, including some or all of those mentioned above, alongside the currently used input measure. The new measures of education will be a first step toward publishing alternative measures of the real output of government as a whole. Comments from the Advisory Committee are welcomed and appreciated.

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